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Improvement of the Quality of Retorted Kamaboko—I
Influence of Heating Conditions on the Quality of Kamaboko

Masakatu YAMAZAWA[*1], Makoto MURASE[*1], and Ichizo SHIGA[*1]

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The recent prohibition of AF-2 [2-(2-furyl)-3-(5-nitro-2-furyl) acrylamide] as a food preservative for Kamaboko has required a new retorting procedure of the Kamaboko manufacturers. However, the Kamaboko retorted by the conventional method is sometimes subject to such deteriorations as off-flavor, browning, and decrease of jelly strength. In order to improve these deteriorations, the influence of heating conditions on the quality of Kamaboko was examined.

Hydrogen sulfide was found to be the most prominent off-flavor component of retorted Kamaboko, by means of sensory investigation and chemical analysis. The production of hydrogen sulfide in Kamaboko started at about 80°C in the 30 min heating process and increased exponentially with rising temperature. Jelly strength and water holding capacity were enhanced with rising temperature below 100°C, but markedly weakened above 100°C. Browning was generated at 115°C or above. The production of hydrogen sulfide and the degree of browning increased with increasing time of heating at 120°C, and jelly strength and water holding capacity were weakened under the same conditions. However, the higher temperature was more effective in preventing the deterioration of retorted Kamaboko, provided that the condition of sterilization was kept at 4 in F_0 value.

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The 1974 prohibition on the use of AF-2[2-(2-furyl)-3-(5-nitro-2-furyl) acrylamide] has resulted in the obligatory storage of specially packaged kamaboko (casing and retainer types) at under 10°C. Thus, products aimed at room temperature circulation must now be sterilized, either by heating the central portion at 120°C for 4 minutes, or by another more effective method. Other requirements for these products are pH under 5.5 and water activity under 0.94.[1,2]

In the fish paste products industry, efforts are being made in the actualization of methods of heating at 120°C. However, almost no studies exist on kamaboko heated at 120°C for 4 minutes (henceforth called "retorted kamaboko"), and concern is focussing on measures against deteriorations in quality, such as off-flavor/odor (hereafter called "off-flavor"), browning, and decreased jelly strength.

The present study was undertaken with the aim of suppressing these deteriorations in kamaboko quality which accompany high-temperature heating. First, the principal components of causes of off-flavor are elucidated. Also reported are relationships of heating conditions to amounts of off-flavor components formed, to browning levels, jelly strength and water expression rates.

[1,2] The F value (sterilizing value)[3] means the time (minutes) taken for the food product to be heated under regular temperatures. This F value is obtained as follows:

$$F = \int_0^t \log^{-1}\left(\frac{T - T_r}{z}\right) dt$$

188

In the above,

T = temperature at the lowest-speed heating point of the food
Tr = regular temperature
z = heat resistance parameter of microorganisms

The Fo value is the F value when Tr = 121.1°C and z = 10°C.
Fo = 4 means heating conditions with a sterilizing effect equal to heating at 121.1°C for 4 minutes.

EXPERIMENTAL

187

Preparation of retorted kamaboko

The basic material was frozen ground pollock (unsalted, grade SA). Added were sodium chloride 3% (w/w) and cold water 20% (v/w), to prepare the salted ground flesh by the usual method. The preparation was packed into a vinylidene chloride tube (bend radius 45 mm x 30 cm; diameter of product about 3 cm), and sealed. It was then heated in a high-speed, hot water reservoir type sterilizer (Sun Plus Co.). Heating conditions were set so that the centre of the kamaboko would be heated at 120°C for over 4 minutes ($Fo^{*2} \geq 3.1$). It was considered that when the heating reservoir temperature was 122°C, about 17 minutes were required 188
to reach a product temperature of 120°C, and the total heating time to reach Fo = 4 was about 20 minutes. The temperature of the kamaboko centre and the Fo value were measured with an Ellab Co. thermometric apparatus and its auxiliary Fo value calculator. The heated samples, after cold-water cooling, were left overnight in a refrigerator, then submitted to various measurements.

Determination of hydrogen sulfide, mercaptans and other sulfides

In accordance with the McLAY method[4], determination followed the methylene blue technique.

Determination of volatile basic nitrogen (VBN), dimethylamine (DMA), and trimethylamine (TMA)

Means of determination were: for VBN, the microdiffusion method[5], for DMA, the copper-dithiocarbamate method[6], and for TMA, the picrate method (improved by TOZAWA et al.[7]).

Jelly strength

Obtained by an Okada Gelometer[8] (Sanko Irika Mfg.) was jelly strength (g.cm) = 1/2 {breaking load (g) x size of depression (cm)}.

Expressible water

A small hydraulic compressor (Sanko Irika Mfg.) was used to obtain expressed water at a pressure of 10 K/cm^2, 20 seconds. The ratio of expressed water in relation to the total moisture was taken as the expressible water rate.[8]

Color tone

A color-difference meter (Nihon Denshoku Kogyo Mfg.) was used to measure values: L (brightness), a (+:red, -:green) and b (+:yellow).[9]

RESULTS AND DISCUSSION

Estimation of components causing off-flavor, based on sensory tests

To elucidate the principal components of causes of off-flavor in retorted kamaboko, various chemicals were added to it, and changes in off-flavor before and after addition were investigated through sensory tests. Results were as follows:

The pH of retorted kamaboko with an equal amount of water added, and homogenized, was 6.8; the result was off-flavors like that of a sulfur compound, and of steamed or burnt kamaboko. Next, with the

purpose of suppressing the sulfur compound odor, to 45g of the kamaboko homogenate above described were added 5 mL of 1N NaOH solution, or 5 mL of 3% $HgCl_2$ solution, and flavor and odor changes were investigated. The sample with NaOH added had a pH of 11.6; the sulfur compound off-flavor vanished and an unpleasant amine odor occurred. The sample with added $HgCl_2$ had pH 6.3; the sulfur compound flavor vanished, giving way to a dried sardine flavor. To suppress volatile basic (VB) and volatile carbonyl compounds (VC), 5 mL of 2N H_2SO_4 solution, or 5mL of 2N H_2SO_4 solution containing 0.1% 2,4-dinitrophenylhydrazine were added; investigation was carried out following the above method. In each case, the resulting pH was 1.2, and some change in flavor was observed. but there was no change in the odor including sulfur compounds. This time, there was no distinctive acidic off-flavor such as volatile fatty acid (VFA); this was thought to have been cancelled out by the intensity of the sulfur off-flavor.

From the above results, it was thought that the principal component causing off-flavors in retorted kamaboko is sulfur compounds, followed by VB, and that VC and VFA also exert some influence.

Determination of sulfur compounds

As reported above, sulfur compounds were considered the main component causing off-flavor in retorted kamaboko, and so hydrogen sulfide, mercaptans and other sulfides in retorted kamaboko were determined. Results appear in Table 1, clearly showing that H_2S composed the greatest

Table 1. The amount of sulfur-compounds in retorted Kamaboko sterilized under the condition of F_0-value 4*1 at 122°C

Sulfur-compounds	Amount (μg/g protein)
Hydrogen sulfide	10.4
Mercaptans	trace*2
Other sulfides	trace*2

*1 F_0-value=4 means a heat process in sterilizing effect equal to heating of 4 min at 121.1°C.
*2 for less than 1 μg/g protein.

part of the sulfur compounds formed in retorted kamaboko. In addition, analysis by gas chromatogoraphy with a flame photometer showed about 350 ng/g methyl mercaptan and dimethyl sulfide respectively in protein. A later report will provide details on these compounds.

Contribution of hydrogen sulfide and VB compounds to off-flavors

MIWA et al.[10] report that among the volatile substances generated when fresh pollack flesh was boiled, most were VBs, with small amounts of sulfur compounds, very little VFA, and no VC. One of the present authors, too, has reported that VBs predominate in the off-flavor components of water vapor distillates of frozen ground pollock, and that H_2S is also present.[11]

From these reports and the results of the previous section, it was thought that the principal components causing off-flavors were H_2S and VB; investigation was made as to what degree these components contributed to off-flavors in retorted kamaboko.

From the same raw materials, retorted and ordinary kamaboko (90°C, heated 40 minutes) were made, and for each, the content of H_2S, NH_4OH, DMA, and TMA were measured. Results appear in Table 2. The H_2S content of retorted kamaboko, at 1.5 ppm, is about 8 times that of ordinary kamaboko; amounts of NH_4OH, DMA and TMA, at 225, 11.5 and 15.0

189

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Table 2. Contribution of hydrogen sulfide and volatile bases to off-flavor in retorted Kamaboko

Compound	Amount (ppm) in		Odor threshold (ppm)		Flavor value*3	
	Ordinary*1 Kamaboko	Retorted*2 Kamaboko	The authors	Referred data	Ordinary*1 Kamaboko	Retorted*2 Kamaboko
Hydrogen sulfide	0.18	1.50	0.003	0.01[14]	60	500
Ammonia	120	225	70	110[14]	1.7	3.2
Dimethylamine	3.6	11.5	—	30[14]	0.3	0.4
Trimethylamine	6.4	15.0	0.6	0.6[14]	10.7	25

*1 Ordinary Kamaboko was processed at 90°C for 40 min.
*2 Retorted Kamaboko was processed at 122°C for about 20 min, which corresponds to F_0-value 4. (See the footnote of Table 1)
*3 Flavor value is expressed as the ratio of 'amount of compound (ppm)' to 'odor threshold (ppm)'. In this table, odor thresholds of the authors were applied for the calculation except for the case with dimethylamine.

ppm, were respectively 1.9, 1.3 and 2.3 times those of ordinary kamaboko, and compared to H_2S, the rate of increase of amounts formed with high-temperature heating was small. Furthermore, amounts of H_2S in relation to total VB were 0.1% for ordinary kamaboko and 0.6% for retorted kamaboko, and H_2S was quantitatively very low.

In order to investigate the level of contribution of chemical substances to off-flavor, their respective odor threshold values must be considered. Methods for this include the weight peak height method[12], the unit flavor base method[13], and the flavor value method[14]. In the present experiment, based on the method of AMOORE et al.[15], the odor threshold values (ppm) obtained by a panel of personnel members of this Institute, which are values with the various components (ppm) excluded, are expressed as "flavor value"[14]; they appear in Table 2. Amounts of H_2S were small, but the odor threshold was very low, at 0.003 ppm, and when expressed as "flavor value", the value for retorted kamaboko, at 500, became very high compared to 60 for ordinary kamaboko. On the other hand, among VBs, the "flavor value" of TMA was the highest, at 10.7 for ordinary and 25 for retorted kamaboko, but for NH_4OH and DMA, since the odor threshold is high for each, the flavor value even for the retorted type was very low. Therefore, in relation to off-flavor occurring in retorted kamaboko, it became clear that the contribution of H_2S was

extremely high, compared to VB. From these results, it was considered that in retorted kamaboko, the flavor value of H_2S increased markedly, compared to VB, upsetting the balance of the components of kamaboko off-flavor, so that a sensory evaluation of off-flavor resulted.

Thus, in subsequent testing H_2S was made the index component of off-flavor, and the degree of off-flavor indicated by the H_2S content.

Effects of increased temperature on kamaboko quality

Salted ground flesh prepared by the above method was packed in a vinylidene chloride tube and heated at 70-125°C for 30 minutes. At 70-98°C, heating was in boiling water, and at 110-125°C, in a high-speed hot water reservoir type sterilizer. Measured for off-flavors was the H_2S content, for browning, the L, a, b values, and for physical properties, jelly strength and expressible water rate in order to determine kamaboko quality.

Amounts of H_2S produced are shown in Fig. 1, jelly strength and expressible water in Fig. 2, and browning levels in Table 3. Amounts of

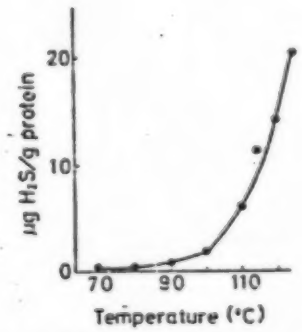

Fig. 1. Influence of temperature in a 30 min heating process of Kamaboko on the production of hydrogen sulfide.
In the 70-98°C heating processes, the samples were dipped in hot water of the respective temperatures.
In the 110-125°C heating processes, hot water retort was applied.

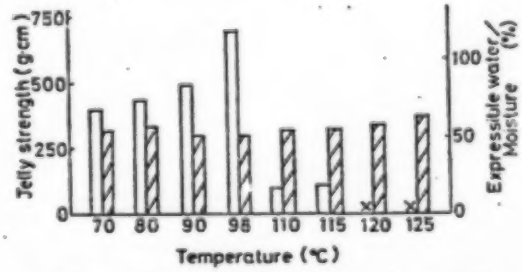

Fig. 2. Influence of temperature in a 30 min heating process*1 of Kamaboko on jelly strength*2 and expressible water.
□: Jelly strength (g. cm)
▨: Expressible water
*1 See the footnote of Fig. 1.
*2 Jelly strength (g·cm): 1/2(breaking load (g)×breaking strain measured on the chart (cm))
The measurement was performed by use of OKADA's Gelometer equipped with a spherical plunger of 5 mm diameter.
×: The measurement of jelly strength could not be applied due to the degration of these two samples.

Table 3. Influence of temperature in a 30 min heating process*1 on browning of Kamaboko

Temperature (°C)	Color value*2		
	L	*a*	*b*
70	66.7	−2.35	3.41
80	67.1	−2.26	3.25
90	66.2	−2.46	3.15
98	66.9	−2.26	2.96
110	66.6	−2.31	3.66
115	65.0	−2.09	3.94
120	64.0	−1.97	4.17
125	62.5	−2.07	4.95

*1 See the footnote of Fig. 1.
*2 *L*: lightness, *a*: + redness, − greenness, *b*: + yellowness.

H_2S increased gradually with rising temperature, up to 98°C, but around 189
110°C they increased sharply, and at 120°C, there was high production (14.6 μg/g protein) about 16 times the value at 90°C. These results indicated a tendency similar to changes in H_2S production when myofibryls of beef are heated at 70-120°C for 30 minutes.[17]

The precursor substance of H_2S is supposed to be cysteine residues 190
in protein[17]. It is said that in this H_2S production, protein becomes denatured at high temperature heating; concomitantly, the inactive SH groups in protein become activated, and part of them become an S-S group; the rest become H_2S.[17,18] In retorted kamaboko as well, the same reaction occurs as in the results of the above study, and H_2S may be considered to form. Therefore, further investigations are required on changes in cysteine content or SH groups in kamaboko.

As for jelly strength, it increased with rising temperature up to 98°C, but at 110°C declined sharply; above 120°C it could not be measured.

Similarly, the expressible water rate decreased gradually until 98°C, but in contrast it increased at 110°C, and lowered water holding capacity was observed.

For browning, no great changes were observed until 110°C, but above 115°C, L values declined and b values increased slightly; some faint browning could also be discerned with the naked eye.

As stated above, it became clear that when kamaboko was heated above 100°C, especially from about 110°C, the result is a decided decline in quality, such as increased H_2S production, lowered jelly strength, increased expressible water, and increased browning.

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Effects of heating time on kamaboko quality

When retorted kamaboko was prepared as above, heating took place for 5, 10, 15 minutes after the centre reached a temperature of 120°C. Changes in various conditions were investigated, as for the previous tests, and comparison was made with the controls (samples heated at 90°C - 40 minutes).

Fig. 3 shows H_2S production. The sample heated at 120°C - 5 minutes had an H_2S production of about 10 times the control, and these amounts increased with time. The sample heated at 120°C - 15 minutes had a production of about 2 times that of the sample heated at 120°C - 5 minutes.

Fig. 4 and Table 4 give results for jelly strength, expressible water and browning. Jelly strength decreased to about 1/2 that of the control heated at 120°C - 5 minutes, and by small degrees, with increased heating time. For the expressible water rate as well, the water holding capacity of the sample heated at 120°C - 5 minutes weakened markedly compared to the control, and weakened again as heating

time was extended. For browning, by heating at 120°C, L values became lower and a and b values higher than those of the control; a slight browning was visible to the naked eye.

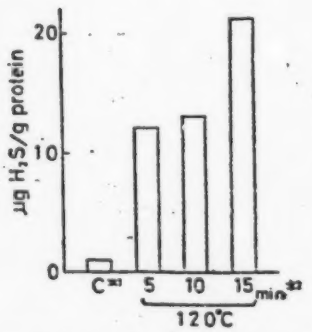

Fig. 3. Influence of heating time at 120°C on the production of hydrogen sulfide in retorted Kamaboko.
*1 Control: Heated at 90°C for 40 min.
*2 The samples were kept for each indicated period after the temperature of the center of the sample reached to 120°C.

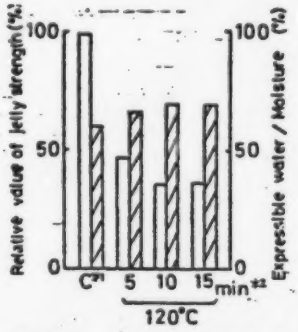

Fig. 4. Influence of heating time at 120°C on jelly strength*3 and expressible water of retorted Kamaboko.
□: Relative value of jelly strength compared with the control
▨: Expressible water
*1,*2 See the footnote of Fig. 3.
*3 See the footnote of Fig. 2.

191

Table 4. Influence of heating time at 120°C on browning of retorted Kamaboko

Heating Conditions	Color value*3		
	L	*a*	*b*
Control*1	65.5	−3.00	0.21
120°C 5 min*2	63.7	−2.48	2.67
120°C 10 min*2	62.5	−2.58	3.21
120°C 15 min*2	62.1	−2.65	3.32

*1, *2 See the footnote of Fig. 3.
*3 See the footnote of Table 3.

Effect on kamaboko quality of heating conditions at same Fo value

As above discussed, for room temperature circulation of specially packaged kamaboko, it is necessary to heat the centre of the product at 120°C for over 4 minutes (Fo $\geqq$ 3.1). Hence different heating conditions at the same Fo value (=4) were established, and retorted kamaboko was prepared according to those heating conditions. To reach Fo=4, 45 minutes were required at a temperature of 115°C, 26 minutes at 120°C, and 16 minutes at 125°C.

Fig. 5 shows H_2S production in these heating conditions. As it shows, the higher the temperature, the lower the H_2S production, and H_2S production of the sample at 125°C was 1/2 that of the sample heated at 115°C. On this point, PERSSON et al.[19] also report that when canned beef

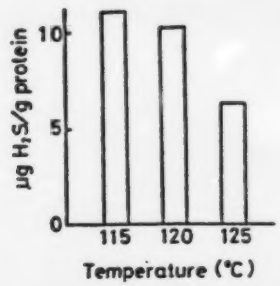

Fig. 5. Influence of heating condition at the same F_0-value (=4)* on the production of hydrogen sulfide in retorted Kamaboko. The corresponding heating conditions with the same F_0-value* were 45 min at 115°C, 26 min at 120°C and 16 min at 125°C, respectively.
* See the footnote of Table 1.

is heated at equal F values at 115, 121, 131°C, the sulfur compounds and aldehydes decrease with rising temperature, and that the degree is especially marked at 131°C.

As for jelly strength, as shown in Fig. 6, when a sample was heated at 125°C, the value was high, about 3.3 times that of the sample at 115°C. The expressible water rate decreased with rising temperature. For browning, moreover, Table 5 shows that the sample heated at 125°C had the weakest values.

Thus, with the same Fo value, the higher the temperature was raised, the higher the quality of the product obtained. 192

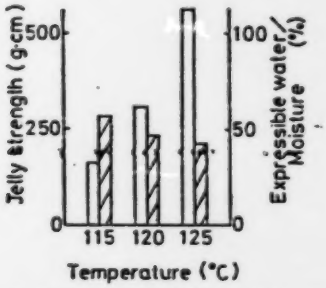

Fig. 6. Influence of heating conditions*1 at the same F_r value (=4)*2 on jelly strength*3 and expressible water of retorted Kamaboko.
*1 See the footnote of Fig. 5.
*2 See the footnote of Table 1.
*3 See the footnote of Fig. 2.

191

Table 5. Influence of heating condition at the same F_r value (=4)*1 on browning of retorted Kamaboko

Heating Conditions	Color value*2		
	L	*a*	*b*
115°C, 45 min	63.7	−2.20	5.04
120°C, 26 min	65.0	−1.82	4.44
125°C, 16 min	64.8	−2.08	4.23

*1 See the footnote of Table 1.
*2 See the footnote of Table 3.

192

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REFERENCES

1) 厚生省告示第 270 号 (昭和 49 年 9 月 30 日).
2) 厚生省告示第 17 号 (昭和 52 年 2 月 18 日).
3) 例えば, 松田典彦: 食品衛生研究, 27, 513-526 (1977).
4) R. McLay: *J. Sci. Fd. Agric.*, 18, 605-607 (1967).
5) 厚生省環境衛生局監修: 食品衛生検査指針 (1) 検査法別, (社) 日本食品衛生協会, 東京, 1973, pp. 30-32.
6) W. J. Dyer and Y. A. Mounsey: *J. Fish. Res. Bd. Canada*, 6, 359-367 (1945).
7) 戸沢晴己・福原和子・天野慶之: 日水誌, 36, 606-611 (1970)
8) 岡田 稔: 東海水研報, No. 36, 74-79 (1963).
9) 色彩科学協会編: 色彩科学ハンドブック, 南江堂, 東京, 1966, pp. 234-237.
10) 三輪勝利・徳永俊夫・飯田 稔: 東海水研報, No. 86, 7-27 (1976).
11) 山澤正勝: 愛知食工試年報, No. 18, 54-60 (1977).
12) D.G. Guadagni, S. Okano, R.G. Buttery, and H.K. Burr: *Food Technol.*, 20, 518-521 (1966).
13) E.S. Keith and J.J. Powers: *J. Food Sci.*, 33, 213-218 (1968).
14) 菊池武昭・和田 俊・鈴木平光: 栄養と食糧, 29, 147-152 (1976).
15) J.E. Amoore, D. Venstrom, and A.R. Davis: *Percept. Motor Skills*, 26, 143-164 (1968).
16) E.L. Pippen and E.P. Mecchi: *J. Food Sci.*, 34, 443-446 (1969).
17) R. Hamm and K. Hofman: *Nature*, 207, 1969-1971 (1965).
18) 渡辺乾二: 日農化, 50, (11) R225-R231 (1976).
19) T. Persson and E.V. Sydow: *J. Food Sci.*, 39, 406-413 (1974).

1. Koseisho kokuji (Ministry of Health and Welfare Bulletin), no. 270, Sept. 30, 1974.

2. Same as above, no. 17, Feb. 18, 1977.

3. For example, MATSUDA, Norihiko, Shokuhin Eisei Kenkyu (Food Sanitation Research), 27, 513-526 (1977).

5. Koseisho Kankyo Eiseikyoku Kanshu (Ministry of Health and Welfare, Environmental Health Bureau, ed.), Shokuhin Eisei Kensa Shishin (Food Sanitation Inspection Index), I, Kensa-ho betsu (by method of inspection), Nihon Shokuhin Eisei Kyokai (Japan Food Hygiene Society), Tokyo, 30-32 (1973).

7. TOZAWA, Hareki, ENOHARA, Kazuko, AMANO, Keisuke, Nissuishi (Bulletin of the Japanese Soc. of Scientific Fisheries), 36, 606-611 (1970).

8. OKADA, Minoru. Tokaisui Kenpo (Bull. of the Tokai Regional Fisheries Research Lab.), 36, 74-79 (1963).

9. Shikisai Kagaku Kyokai hen (Color Science Association, ed.), Shikisai Kagaku Handobukku (Color Science Handbook), Nankodo, Tokyo 234-237 (1966).

10. MIWA, Katsutoshi, TOKUNAGA, Toshio, IIDA, Haruka, Tokaisui Kenpo (same as in Note 8), 86, 7-27 (1976).

11. YAMAZAWA, Masakatsu, Aichi Shokko-shi Nenpyo (Annual Report of the Food Research Inst., Aichi Prefecture), 18, 54-60 (1977).

14. KIKUCHI, Takeaki, WADA, Shun, SUZUKI, Hiramitsu, Eiyo to Shokuryo (Journal of the Japanese Soc. of Food & Nutrition), 29, 147-152 (1976),

18. WATANABE, Kenji, Nichi Noka (Journal of the Agricultural Chemical Society of Japan), 50, (11)R225-R231 (1976).